SiMKit
Release Notes

for SiMKit version 2.4

First Edition

NXP Semiconductors
ED&T/Analogue Simulation

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Preface

These are the release notes for *SiMKit* version 2.4. All changes with respect to *SiMKit 2.3.2* are reported in these release notes.

Overview

SiMKit is a simulator-independent compact transistor model library.

Simulator-specific connections are handled through so-called adapters that provide the correct interfacing to:
– *Spectre*, the circuit simulator from *Cadence*
– *Pstar*, the circuit simulator from *Philips*
– *ADS*, the circuit simulator from *Agilent*.

The *SiMKit* library contains the most recent versions of the *NXP* transistor models. The following tables list the *SiMKit* models. The first table lists the *SiMKit* models, the second table lists the models for which only a *Pstar* and *Spectre* implementation are available.
For a full description please check:

`http://www.nxp.com/Philips_Models/`

In the following tables **e/g** stands for electric / geometric, **t** stands for self-heating and **s** stands for substrate model.

Table 1: Real SiMKit models

Model	Level	Pstar	Spectre	ADS	e/g	t	s
juncap	1	juncap	juncap	juncap	e	no	no
juncap	200	juncap	juncap200	juncap200	e	no	no
psp	102	pspe	psp102e	psp102e	e[a]	no	no
psp	1020	psp	psp1020	psp1020	g[a]	no	no
psp	1021	psp	psp1021	psp1021	g[a]	no	no
pspnqs	102	pspenqs	pspnqs102e	pspnqs102e	e[a]	no	no
pspnqs	1020	pspnqs	pspnqs1020	pspnqs1020	g[a]	no	no
pspnqs	1021	pspnqs	pspnqs1021	pspnqs1021	g[a]	no	no
modella	500	tpl	bjt500	bjt500	e	no	no
modella	500	tplt	bjt500t	bjt500t	e	yes	no
mextram	504	tns/tps	bjt504	bjt504	e	no	yes

Table 1: Real SiMKit models

Model	Level	Pstar	Spectre	ADS	e/g	t	s
mextram	504	tnst/tpst	bjt504t	bjt504t	e	yes	yes
mextram	504	tn/tp	bjtd504	bjtd504	e	no	no
mextram	504	tnt/tpt	bjtd504t	bjtd504t	e	yes	no
mos	1100	mne/mpe	mos1100e	mos1100e	e	no	no
mos	1100	mn/mp	mos1100	mos1100	g	no	no
mos	1101	mne/mpe	mos1101e	mos1101e	e	no	no
mos	1101	mnet/mpet	mos1101et	mos1101et	e	yes	no
mos	11010	mn/mp	mos11010	mos11010	g	no	no
mos	11010	mnt/mpt	mos11010t	mos11010t	g	yes	no
mos	11011	mn/mp	mos11011	mos11011	g	no	no
mos	11011	mnt/mpt	mos11011t	mos11011t	g	yes	no
mos	1102	mne/mpe	mos1102e	mos1102e	e	no	no
mos	1102	mnet/mpet	mos1102et	mos1102et	e	yes	no
mos	11020	mn/mp	mos11020	mos11020	g	no	no
mos	11020	mnt/mpt	mos11020t	mos11020t	g	yes	no
mos	11021	mn/mp	mos11021	mos11021	g	no	no
mos	11021	mnt/mpt	mos11021t	mos11021t	g	yes	no
mos	2001	mne/mpe	mos2001e	mos2001e	e	no	no
mos	2001	mnet/mpet	mos2001et	mos2001et	e	yes	no
mos	2001	mn/mp	mos2001	mos2001	g	no	no
mos	2001	mnt/mpt	mos2001t	mos2001t	g	yes	no
mos	2002[b]	mne/mpe	mos2002e	mos2002e	e	no	no
mos	2002[b]	mn/mp	mos2002	mos2002	g	no	no

Table 1: Real SiMKit models

Model	Level	Pstar	Spectre	ADS	e/g	t	s
mos	3100	mn/mp	mos3100	mos3100	e	no	no
mos	3100	mnt/mpt	mos3100t	mos3100t	e	yes	no
mos	40	mn/mp	mos40	mos4000	e	no	no
mos	40	mnt/mpt	mos40t	mos4000t	e	yes	no

a. Note that for the PSP-model the electrical model is referred to as the local model and the geometrical model as global.
b. Note that the Mos 2002 is a test version in *SiMKit 2.4*.

Table 2: Other (older) models (Pstar and Spectre specific)

Model	Level	Pstar	Spectre
diode	500	d	dio500
mos	3002	mn/mp	mos3002
mos	902	mn/mp	mos902
mos	902	mne/mpe	-
mos	903	mn/mp	mos903
mos	903	mne/mpe	-
mextram	503	tn/tp	bjt503
mextram	503	tns/tps	bjt503
lpnp	301	tpl	bjt301
mos	705	mne/mpe	mos705

Release notes

The release notes can be obtained by entering the following command:

```
cadenv -q simkit
```

1 Improvements

PSP

- The PSPNQS model is now available in *SiMKit*. This spline collocation-based nonquasi-static (NQS) model is developed to include all regions of operation and small geometry effects. This *SiMKit* implementation has some known limitations that could cause convergence problems.
- Clipping boundaries have been added for the parameter SWNQS (switch for NQS effects).
- Several minor changes and improvements to the model implementation.
- Solved bug in stress model.
- The initial guess for PSP was implemented incorrectly for p-type devices, this has been corrected for the implementation in *Spectre*. For *Pstar* the problem still needs to be solved.
- Note that Juncap2 changes (see below) also influence PSP.

Mextram 504

- For Mextram 504 several convergence problems have been solved.
- The derivatives used in the calculations of the model have been made more robust.
- The temperature derivatives have been made robust.
- The lower clip value of BRI has been changed from 1e-4 to 1e-10.
- Performance of temperature scaling has been improved.
- To improve convergence in the model, the self-heating effect is included in the explosion voltage for the spectre part of the model. The explosion voltage is updated and not constant anymore. The implemented code was suggested by cadence to improve convergence, however, the temperature derivatives of the explosion voltage are not taken into account.

MOS1102

- Parameter for (short-channel) subthreshold slope for the actual transistor (MO) is implemented in mos1102e. The new MO high clip value is 0.5.
- A problem occured in one of the model equations, where the combination of parameters and voltages led to a negative argument of a squareroot function. The equation has been rephrased to avoid the problem.
- Some minor performance improvements.

MOS1101

- The description for the following parameters has been corrected. This description can be seen with **`spectre -h`** `<modelname>`. The parameters are unitless: `swthesr`, `swtheph`, `swetamob`, `swther`, `swthesat`, `swtheth`, `slssf`, `swssf`, `swalp`, `sla1`, `swa1`, `sla2`, `swa2`, `sla3`, `swa3`.

MOS2002

– Avalanche current has been included in the model. Please note that some parameters have a new name, and some parameters have been added. Details can be found in the Modelbook.

Juncap level1

– Parameters `VDB` (diffusion voltage of bottom area),
`VDS` (diffusion voltage of Locos-edge),
`VDG` (diffusion voltage of gate edge) are clipped due to changes in the behaviour of juncap.
– Implementation for `MULT=0` is more efficient.

Juncap level 200

– The band-to-band tunneling equations have been modified.
At temperatures lower than the reference temperature, `Vj` can become lower than `VBIR`. This caused numerical problems in the model, which in turn resulted sometimes in convergence problems in the simulator. An alternative formulation of the equations has been implemented that avoids these problems.
– Some minor bugfixes.

All MOS and bipolar devices

– There was a warning regarding specifying the working region for `bjt` models and MOSFET models when using **`spectre -h`** `<model name>`. This warning is removed.

All MOS devices

– In the past an unclear warning was given when the effective length and/or effective width of a transistor were clipped. This warning has been made more specific, for example:

```
<WARNING> SiMKit: Effective width in mos device MN_1 becomes
negative or zero, value set to small positive (1.0e-9) value.
```

All Self-heating models

– For all self-heating models a `gmin` convergence aid has been implemented. This makes the convergence more robust. The results are not always only positive but also in some cases the convergence may be slower. The `gmin` convergence aid implementation has been made common to all simulators.
– The performance of self-heating models has been improved by reducing the time spent in clipping.

Pstar specific issues

– The change block parameter `print_clip_warnings` has been fixed.
SiMKit now correctly interprets the change block parameter `print_clip_warnings`. With previous *SiMKit* versions, the clip warning was always printed.
– A bug in the code that handles source drain interchange for mos models has been fixed.

Spectre specific issues

– With *SiMKit 2.4* the flicker noise contribution is now separately available in the output.
– Note: Some problems have been seen with transient noise analysis `cadence_mmsim` versions before 6.0.2.247.
– *SiMKit 2.1.1* and *2.2* can give wrong results on *HP* when *cadence_ic* versions 5.10.41* or higher are used. Please use *SiMKit 2.3* or higher.

ADS specific issues

– New noise types `SK_NT_THERMAL`, `SK_NT_SHOT`, and `SK_NT_FLICKER` are implemented and now a more efficient noise function can be used. This can speed up the HB/noise analysis.
– With *SiMKit 2.4* the flicker noise contribution is now separately available in the output.
– The coulomb scattering parameters were missing in the *ADS* design kit. They have been added.
– The temperature sweep for *SiMKit* models did not work properly, unless a definition of an instance parameter temp was used.

E.g.: `qmod:q1 d g 0 0 Temp=temp`

This workaround is no longer required with *ADS 2006A*.

– *ADS 2006A* release (for 32 and 64 bits) on *Linux* is supported.
– When you want to use the *ADS* GUI and/or simulator from the *Cadence* environment you have to use `rfde` as startup command. Otherwise, the environment for *ADS* is not correctly set up, and one of the consequences is that the *SiMKit* can not be found.

UltraSim and AMS Designer specific issues

– *SiMKit 2.3.1* and *2.3.2* are incompatible with *UltraSim* (and with *AMS Designer* using *UltraSim*): *UltraSim* will crash with a memory fault.

SiMKit 2.4 is compatible with *UltraSim* from *cadence_ius* version 5.7 and higher.

General

The *SiMKit* library has been split up in two libraries: one library containing the simulator interface functions, and the other containing the device models. As a consequence of this split, the *SiMKit* version message will show two version numbers: one for the simulator specific library, and one for the device models library.

There are several advantages to this split. One of the most important is that the amount of disk space consumed by a *SiMKit* distribution has become considerably lower. In spite of this, the disk space has increased due to addition of the `PSPNQS` model.

Software specific issues

The *SiMKit* Interface has been updated from version 1.2 to 1.3. The changes are:

– `p_get_model_params` now takes a `p_sim_data` pointer as an extra parameter to handle scaling. This parameter has been introduced to implement scaling using the `scalem` parameter in *Spectre*.
– The `SK_PARAM_DESCRIPTOR` structure has a new field `scaling_type` that is used to implement the `scale` and `scalem` parameters in *Spectre*.
– `SK_REP_NEGATIVE_W_OR_L` has been replaced with `SK_REP_NEGATIVE_WEFF` and `SK_REP_NEGATIVE_LEFF`.

For a complete description, please read the *SiMKit* interface description.

2 Known limitations

Known limitations

The following known limitations are in *SiMKit 2.3*, *2.3.1* and *2.3.2*:

– `MOS2002` and `PSPNQS` are not available in the *ADS* designkit.